FINAL TECHNICAL REPORT

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Entitled "Investigation of Nerve and Muscle Breakdown During Spaceflight"

Cosmos 2044 Experiment K-7-09

Covering the period from 5/15/87 to 9/30/91

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Summary of the Work

The results from the 14-day Cosmos 2044 mission reconfirmed that adductor longus (AL) muscle fibers atrophied during spaceflight and tail suspension hindlimb unloading. However, the mean wet weight of flight AL muscles was near normal whereas that of the suspended AL muscles was significantly decreased. Interstitial edema, not present in the suspended AL, largely accounted for this finding. SO fibers were more atrophied than FOG and FG fibers, and SO fibers synthesized fast myosin, producing hybrid fibers containing both slow and fast myosin isoforms. In the flight AL, absolute mitochondrial content decreased but the relative greater breakdown of myofibrillar proteins maintained mitochondrial concentration near normal in the central regions of fibers. Subsarcolemmal mitochondria were preferentially lost and decreased below normal. Upon return to weightbearing, the weakened muscles exhibited eccentric contraction-like lesions, disruption of the sarcomeres and the supporting connective tissue, and the thrombosis of the microcirculation. Segmental necrosis of muscle fibers, denervation of neuromuscular junctions, and extravasation of rbc's were uncommon. The lymphocyte antibody markers did not indicate a significant immune reaction. The flight AL exhibited more eccentric lesions than the suspended AL; the high reentry G forces experienced by the flight animals, but not the suspended group, appeared to explain this difference. Muscle atrophy apparently increased the susceptibility to eccentric contraction damage following reloading; this may reflect weakening of the muscle fiber cytoskeleton and connective tissue. Microcirculation was also compromised by spaceflight because there was an increased formation of thrombi in the postcapillary venules and capillaries. Blockage would lead to edema within a few hours of resuming weightbearing and 2 days later, extensive tissue necrosis and microhemorrhages would occur as observed for Cosmos 1887. The possibility exists that muscle-derived emboli will travel to the lungs, producing a more serious health problem. Countermeasures designed to maintain the health of the muscle and the organism during spaceflight and upon return to Earth's gravity will have to deal effectively with the multifaceted nature of the problem.

Publications and Presentations of This Work

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